REMARKS

Applicants respectfully request reconsideration of the rejected claims in view of the foregoing amendments and the following remarks.

Claim Status

Claims 1-25 were pending in this application. Claims 1, 5-6, 10, 13, 16, and 20-22 have been amended for clarity.

Claim Rejections – 35 USC §101

The Examiner has rejected claims 1-25 under 35 USC §101, asserting that the claimed invention is directed to non-statutory subject matter. In particular the Examine asserts that the claim invention is not a practical application that produces useful, concrete, and tangible results and that the claimed invention manipulates data, but does not produce a tangible, useful, concrete, and tangible real-world result that can be perceived by the senses. The Applicants traverse these rejections because the Examiner fails to make a *prima facie* showing that the claimed invention lacks utility as required by MPEP 2107.02. The Examiner has failed to provide any evidentiary basis for the rejection and has not provided a detailed explanation why the claimed invention has no specific and substantial credible utility as required by that section.

All of the claims include specific statements of substantial practical purpose of the present invention. For example, claim 1 is for "Apparatus for converting the output signals of a logging tool into a log representing a parameter of earth formations surrounding a borehole ..." The remaining claims recite apparatus and methods for essentially the same purpose.

Well logs are physical displays or representations of characteristics of earth formations surrounding a borehole. Such logs are very useful to oil explorationists and drillers so that they can understand the parameters of the formations, such as mineral content, pressure, temperature, etc. and drill safe productive wells. It is well known that the direct outputs of logging tools, called the raw data, is not normally in a form that can be understood by log analysts and reservoir engineers. It normally must be improved and converted into a clear representation of the desired parameter, e.g. resistivity versus depth location. Apparatus and methods for producing such user readable logs are clearly patentable subject matter.

Claim 1 is directed to an improved tool for converting raw data into such a log. Claims 2-25 are directed to similarly useful apparatuses and methods. For at least this reason, claims 1-25 clearly meet the requirements of 35 USC § 101.

Claim Rejections – 35 USC §112, First Paragraph

Claim 4-6, 13, 16 and 21-22 were rejected under 35 USC §112 as failing to comply with the enablement requirement. The Examiner asserts that these claims contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains to make and/or use the invention.

As to claim 4, the Examiner asserts that it is directed to combining the outputs of said neural network to generate an average value for each depth point in the borehole, but according to claim 3 the plurality of outputs represents the value of the parameter at a plurality of depth points within the range of depths. The Examiner asserts that if each output represents the value of the parameter at a depth, it is not clear how the outputs could be combined to generate an average value for each depth point given that each output already represents the value of the parameter at a particular depth. The Examiner concludes that the person of ordinary skill in the art would not be enabled to make and/or use this invention.

The Applicants submit that the claim 4 is clearly enabled by the patent specification. The embodiment of Fig. 12 is one example of an apparatus covered by claim 4, and this embodiment is explained in paragraphs [0073]-[0076] of the specification.

The explanation begins with reference to Fig. 11 which shows a multiple-input/single output network. As taught in paragraphs [0052] and [0053], various embodiments were tested with 51 and 101 inputs. These samples are taken over 25 feet of borehole. The neural network of Fig. 11 uses the input samples to produce one output sample at the center of the input values. A rolling set of 51 or 101 samples is input to the network to produce additional output values for each depth point.

However, Fig. 12 extends the neural network. Although the same number of inputs are accepted, the neural network produces a plurality of outputs each corresponding to a different depth point. In paragraph 0076, an embodiment with five outputs is described. In the last sentence of paragraph 0076, it is explained that the 5 outputs may be averaged over the diagonal along which the outputs have the same true vertical depth (TVD) as illustrated in Fig. 13. Thus, at each

rolling window of input data, the network produces outputs at each of five depth points and as the window rolls, five outputs are produced at each depth point and those five outputs are averaged as the final output for the depth point. This description clearly enables one skilled it the art to practice the inventions of claims 3 and 4.

As to claims 5, 6, 13, 16, 21 and 22, the Examiner asserts that these claims cover using synthetic responses and the formation models to train artificial neural networks to generate the formation models. However, the Examiner asserts that it is not clear how the formation models can be used to train the artificial neural networks before said formation models have been generated by said artificial neural network. The Examiner concludes that the person of ordinary skill in the art would not be enabled to make and/or use this invention.

The method of Claim 5 is illustrated in Fig. 4 and described in paragraphs [0050] to [0055]. The target formation 30 is a set of synthetic formation profiles. These profiles may be produced manually according to the description in paragraphs [0057] to [0064] and with reference to Figs. 5 and 6. Once these synthetic profiles are created they may be used for training in the claimed fashion. In other words, a synthetic log response 32 is generated from the synthetic formation profile 30. The synthetic response is processed by the neural network 34 to produce a representation of the formation 36 (i.e., an estimate). A comparison 38 is made between the original target formation 30 and the neural network's estimate 36. Differences are calculated and are used to train the neural network 34 in a manner that tends to improve the neural network's performance.

The process is repeated until the output representation 36 matches the target formation 30 within an acceptable tolerance. Claim 5 covers each of these steps plus the step of using the ANN after training to process actual, not synthetic, logging signals to produce an estimate of actual, not synthetic, earth formations.

If an artificial neural network were perfectly trained, the output representation 36 would be identical to the target formations 30, but it is necessary for the output representations to be a close approximation of the target formations. For this reason, the term "the formation model" has been amended to avoid this confusion. Claim 5 provides that the artificial neural network is trained to generate "representations of" the formation models. Applicants submit that this amendment is supported by the specification and more clearly expresses the intent of the original claim language.

The above remarks are believed to apply equally well to claims 6, 13, 16, 21 and 22. Each of these claims has also been amended in the same way claim 5 has been amended to avoid possible confusion.

In view of the above remarks and amendments, Applicants submit that claims 5, 6, 13, 16, 21 and 22 meet the requirements of 35 USC §112.

<u>Claim Rejections – 35 USC §112, Second Paragraph</u>

Claims 1, 5, 10, 13, 16, and 20-22 were rejected under 35 USC §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention.

With respect to claims 1, 5, 10, 13, 20 and 21, the Examiner asserts that there is insufficient antecedent basis for the limitation "the output signals" in line 1. By the present amendment, this limitation in each of the claims has been changed to read "output signals". In view of this amendment, Applicants submit that these claims meet the requirements of 35 USC §112, second paragraph.

With respect to claims 16 and 22, the Examiner notes that these claims recite the limitation "The process" in line 1 and requires that it be changed to "The method" to provide sufficient antecedent basis. By the present amendment the required changes have been made to claims 16 and 22.

<u>Claim Rejections – 35 USC §102</u>

Claims 1-3 and 5 have been rejected as being anticipated by the Mezzatesta US patent 5,862,513.

As to claim 1, the Examiner asserts that Mezzatesta anticipates: "an artificial neural network trained with a set of synthetic earth formation models selected to cover the operating range of a selected logging tool based on sensitivity and resolution limits of the logging tool and based on realistic ranges of formation parameters", citing columns 3-9 and especially Col. 3, line 25 to Col. 6, line 35; Col. 9, lines 35-55 and Fig. 1A. The Applicants respectfully traverse this rejection.

Mezzatesta does not teach any preferred ranges of an earth model, much less use of a synthetic earth model having the characteristics of claim 1, for training a neural network. The input model of Mezzatesta is intended to match the actual earth formation being measured, that is they

are based on an estimated actual earth formation. See Col. 3, lines 39-40. In contrast, claim 1 requires that the characteristics of synthetic earth models be based on characteristics of the tool, not any real earth formation, much less one that is currently being measured and processed. For at least this reason, Applicants submit that independent claim 1 and its dependent claims 2-3 are patentable over Mezzatesta.

As to claim 5, the Examiner asserts that Mezzatesta anticipates: "creating a set of synthetic earth formation models selected to cover the operating range of a selected logging tool based on sensitivity and resolution limits of the logging tool and based on realistic ranges of formation parameters" citing Columns 3-9, especially Col. 3, line 25 to Col. 6, line 35 and Col. 9, lines 35-55. The Applicants respectfully traverse this rejection. It is clear as discussed above that Mezzatesta does not teach creating synthetic earth models having such characteristics based on the tool in question. Mezzatesta instead teaches creating an estimate of actual earth formations through which a real logging tool has been operated and has generated tool responses, i.e. raw logging data. For at least this reason, Applicants submit that independent claim 5 is patentable over Mezzatesta.

Claim Rejections – 35 USC §103

Claim 4 has been rejected as being unpatentable over Mezzatesta in view of Freedman US patent 5,210,691. Claim 4 depends from claim 1, and thus incorporates the limitations of claim 1. Mezzatesta fails to teach or suggest each element of claim 1 as explained previously. The examiner does not cite, any teachings or suggestions in Freedman regarding neural networks, let alone the limitations of claim 1. Claim 4 additionally requires combining different outputs of a neural network to generate an average value for each depth point in the borehole, which is clearly not taught by either Mezzatesta or Freedman. For at least these reasons, claim 4 is patentable over these references, taken individually or in combination.

Claims 6 and 9 have been rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of Anderson US patent 3,954,006. These claims depend from claim 5 and thus incorporate the limitations of claim 5. Mezzatesta fails to teach or suggest each element of claim 5 as explained previously. The examiner does not cite, and applicants cannot find, any teaching or suggestions in Anderson regarding neural networks, let alone the limitations of claim 5. Claim 6 additionally requires the use of multiple neural networks, which is clearly not taught by either Mezzatesta or Anderson. Claim 9 additionally requires combining different outputs of a neural

network to generate an average value for each depth point in the borehole, which is clearly not taught by either Mezzatesta or Anderson. For at least these reasons, claims 6 and 9 are patentable over these references, taken individually or in combination.

Claims 7 and 8 have been rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of Barber US patent 5,184,079. These claims depend from claim 5 and thus incorporate the limitations of claim 5. Mezzatesta fails to teach or suggest each element of claim 5 as explained previously. The examiner does not cite any teachings or suggestions in Barber of neural networks, let alone the limitations of claim 5. For at least this reason, claims 7 and 8 are patentable over these references, taken individually or in combination.

Claims 10 and 13 have been rejected under 35 USC §103(a) as being unpatentable over Mezzatesta in view of Strickland US patent 5,867,806. As to claim 10, the Examiner notes that Mezzatesta fails to teach: "a. a plurality of chirp models ... having parameter contrasts at layer interfaces limited to realistic contrasts found in actual earth formations, at least one model having an upper parameter limit substantially at the upper limit of the selected tool operating range, and at least one model having a lower parameter limit substantially at the lower limit of the selected tool operating range". To anticipate this limitation, the Examiner cites Strickland columns 1-23 especially col. 18, lines 15-65, col. 5, lines 58-60 and Figs. 10-12.

It is true that in Figs. 7 – 9 Strickland illustrates an Oklahoma type model and in Figs. 10-12 Strickland illustrates two chirp type models. However, each of the Oklahoma models is shown to have the same dynamic range starting with resistivity of 1 ohm-m. The chirp models appear to have dynamic ranges of 1-10 ohm-m and 10-100 ohm-m. Strickland has no teaching of selecting a set of such models having any specific ranges for any specific purpose. The multiple illustrations of Strickland merely illustrate the effect of various dip angles on modeling the same formations. The two ranges of chirp data are used to illustrate that results processed according to the Strickland disclosure have better resolution at lower resistivities, see Col. 18, lines 29-31. Strickland does not teach training an ANN with a set of such models, much less training an ANN with a set, i.e. a plurality, of such models with specific ranges selected based on a tool to be used to collect real data. For at least these reasons, claim 10 are patentable over these references.

As to claim 13, the Examiner notes that Mezzatesta fails to teach: "a. a plurality of chirp models ... having parameter contrasts at layer interfaces limited to realistic contrasts found in

actual earth formations, at least one model having an upper parameter limit substantially at the upper limit of the selected tool operating range, and at least one model having a lower parameter limit substantially at the lower limit of the selected tool operating range". To anticipate this limitation, the Examiner cites Strickland. As explained previously, Strickland fails to provide any such teaching or suggestion. Strickland has no teaching of selecting a set of such models having any specific ranges for any specific purpose. For at least this reason independent claim 13 is allowable over the cited art.

Claims 16 and 19 have been rejected under 35 USC § 103(a) as being unpatentable over Mezzatesta in view of Strickland and further in view of Anderson. Claims 16 and 19 depend from independent claim 13 and hence incorporate the limitations of independent claim 13. As explained above, Mezzatesta and Strickland fail to teach or suggest all the limitations of independent claim 13. The examiner does not cite any teaching or suggestion of chirp models in Anderson. Claim 16 additionally requires the use of multiple neural networks, which is clearly not taught by Mezzatesta, Strickland or Anderson. Claim 19 additionally requires combining different outputs of a neural network to generate an average value for each depth point in the borehole, which is clearly not taught by Mezzatesta, Strickland or Anderson. For at least these reasons, claims 16 and 19 are patentable over these references, taken individually or in combination

Claims 17-18, 20-21, and 23-24 have been rejected under 35 USC § 103(a) as being unpatentable over the combination of Mezzatesta and Strickland in view of Barber. Claims 17-18 depend from independent claim 13 and thus incorporate the limitations of claim 13. Mezzatesta and Strickland fail to teach or suggest each element of claim 13 as explained previously. The examiner does not cite any teachings or suggestions in Barber of neural networks, let alone the limitations of claim 13. For at least this reason, claims 17 and 18 are patentable over these references, taken individually or in combination

As to claims 20 and 21, the Examiner cites Barber as teaching that the parameter contrasts of the models be from 10 to 1 to 100 to 1. It appears that Barber discloses certain earth formations having parameter contrasts of 50 to 1 and 100 to 1, however, these are not synthetic earth formation models used for training neural networks. The Applicants do not claim to have invented earth formations have any particular parameter contrasts. Rather, claims 20 and 21 address the selection of particular synthetic models to use for training a neural network. As previously

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explained, Mezzatesta and Strickland are also deficient on this point. For at least this reason, claims 20 and 21, along with dependent claims 23-23, are allowable over the cited art.

Claims 11-12 and 14-15 have been rejected under 35 USC § 103(a) as being unpatentable over the combination of Mezzatesta and Strickland and Barber in view of Girard US patent 3,509,458. Claims 11-12 depend from independent claim 10, and thus incorporate the limitations of independent claim 10. As explained previously, the combination of Mezzatesta and Strickland fails to teach or suggest particular parameter contrasts for synthetic earth formation models used for training neural networks. The Examiner cites Barber as teaching that the parameter contrasts of the models be from 10 to 1 to 100 to 1. It appears that Barber discloses certain earth formations having parameter contrasts of 50 to 1 and 100 to 1, however, these are not synthetic earth formation models used for training neural networks. The Applicants do not claim to have invented earth formations have any particular parameter contrasts. Rather, claims 11-12 address the selection of particular synthetic models to use for training a neural network. Girard appears to be silent on particular parameter contrasts for synthetic earth formation models. For at least this reason, claims 11-12 are allowable over the cited art.

As to claims 14-15, these claims depend from independent claim 13. As explained previously with regard to claim 13, the combination of Mezzatesta and Strickland fails to teach or suggest particular parameter contrasts for synthetic earth formation models used for training neural networks. The Examiner cites Barber as teaching that the parameter contrasts of the models be from 10 to 1 to 100 to 1. It appears that Barber discloses certain earth formations having parameter contrasts of 50 to 1 and 100 to 1, however, these are not synthetic earth formation models used for training neural networks. The Applicants do not claim to have invented earth formations have any particular parameter contrasts. Rather, claims 14-15 address the selection of particular synthetic models to use for training a neural network. Girard appears to be silent on particular parameter contrasts for synthetic earth formation models. For at least this reason, claims 14-15 are allowable over the cited art.

Conclusion

In the course of the foregoing discussions, applicant may have at times referred to claim limitations in shorthand fashion, or may have focused on a particular claim element. This discussion should not be interpreted to mean that the other limitations can be ignored or dismissed.

The claims must be viewed as a whole, and each limitation of the claims must be considered when determining the patentability of the claims. Moreover, it should be understood that there may be other distinctions between the claims and the cited art which have yet to be raised, but which may be raised in the future.

The Commissioner is hereby authorized to charge payment of any further fees associated with any of the foregoing papers submitted herewith, or to credit any overpayment thereof, to Deposit Account No. 03-2769, Conley Rose, P.C.

Applicants respectfully submit that the present application as amended is in condition for allowance. If the Examiner has any questions or comments or otherwise feels it would be helpful in expediting the application, he is encouraged to telephone the undersigned at (713) 238-8055.

Respectfully submitted,

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